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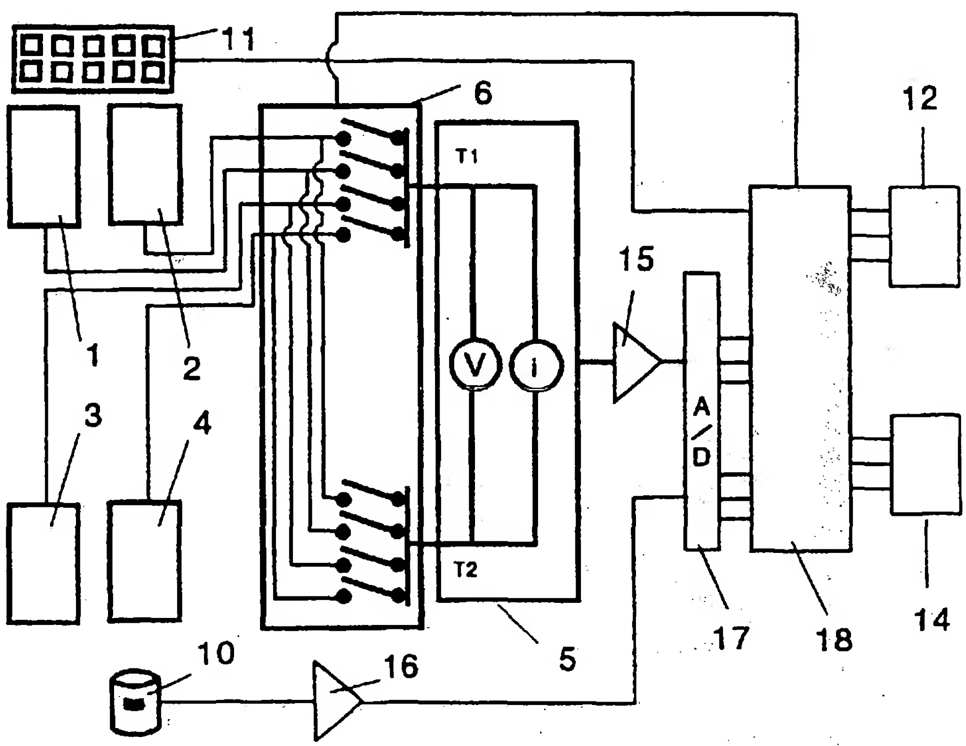
(57) Abstract



The present invention relates to an apparatus for analyzing body composition, which comprises metal plate electrodes (1, 2, 3 and 4) contacting the palms and the soles; an impedance measuring instrument (5) for measuring impedance of the body using the current voltage ratio, which includes a terminal T_1 consisting of a pair of current C_1 and voltage V_1 terminals and a terminal T_2 consisting of a pair of current C_2 and voltage V_2 terminals, thereby an alternating current in the magnitude of 0.1-2.0 mA between 1 KHz and 1 MHz passes between said terminals T_1 and T_2 and a voltage difference is measured between said terminals T_1 and T_2; electronic switches (6) connecting said plate electrodes to said impedance measuring terminals T_1 and T_2; a load cell (10) for measuring the weight; a key pad (11) for inputting the patient data such as height, age, and sex; a microprocessor (18) for calculating the body composition results using measured data; amplifier (15) and filter (16) and A/D converter (17) for interfacing said impedance meter (5) and weight measurement systems (10) to said microprocessor (18); and a display unit (12) for displaying the results.

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APPARATUS AND METHOD FOR ANALYZING BODY COMPOSITION BASED ON BIOELECTRICAL IMPEDANCE ANALYSIS

FIELD OF THE INVENTION

The present invention relates to an apparatus for analyzing body composition based on bioelectrical impedance analysis, and a method therefore. Particularly, the present invention relates to an apparatus for quantitatively analyzing body composition such as body fluid and body fat and the like by measuring the impedance of body segments such as arm, leg and trunk, by contacting the palm of hand and the sole of foot to metal plate electrodes, and by analyzing the measured values.

DESCRIPTION OF THE PRIOR ART

A human body is composed of water, protein, bone and fat, in addition to the small amount of elements. The total of these elements constitutes the body weight. The quantitative measurement for the respective element is called body composition analysis. The percentage occupied by fat is called fatness, and the fatness is used as the criterium for assessing the nutritional status, and also is used in diagnosing various adult diseases. In the medical terms, of the body composition, fat free mass (FFM) is the main components for supporting the human body. Patients associated with the nutrition deficit such as cancer are subjected to a periodically measuring FFM to know the curing state or the progress of the illness. In the case where a fatty man performs exercise to reduce the body

weight, it frequently happens that the body weight shows little variation within a relatively short period of several months. In this case, if the body composition is measured, it may be found that the amount of muscle has increased and the amount of fat has decreased. In this way, the effects of the exercise can be measured in a scientific manner. Further, based on the analysis of body composition, the growth in children and the nutrition status in old men can be diagnosed. Particularly, for various patients, the water distribution can be measured, thereby obtaining a clue for the patient's fluid balance.

There are various conventional methods for measuring body composition. One of them is hydrodensitometry, and this method is carried out in the following manner. The body density is found by measuring the weight under water. Then the amount of fat is calculated, using the body density. This method is based on the principle that fat is lighter than FFM. This method is highly accurate, and therefore, it is used as a standard method. However, it has the disadvantages that it is a troublesome task to carry it out and that it can not be applied to an old man or to a sick person.

Another conventional method is to measure the thickness of the subcutaneous fat layer by using a caliper, ultrasound or near infrared light. These methods has the disadvantage that the accuracy is low.

Further, there are imaging methods based on nuclear magnetic resonance (NMR), dual energy X-ray absorptiometry (DEXA). However, these methods are too expensive to carry out frequently.

Further, there are dilution methods such as heavy water (D_2O) dilution or bromide solution dilution. However, these methods are difficult to use.

As another method for measuring body composition, there is a bioelectrical impedance analysis (BIA). BIA method is safe, inexpensive, and quick.

In the conventional BIA method, a small amount of alternating current is passed through the body and the body resistance is measured. then total body water, water distribution between intracelluar and extracellular water, fat free mass can be determined. Total fat is the weight minus FFM and thus percent body fat can be calculated.

In the conventional method, four surface EKG electrodes or similar electrodes are attached on the wrist , the hand, the ankle, and the foot of an examinee with the supine posture. Then the impedance between the wrist and the ankle is measured. The surface electrodes are often sticky in order to be applied on the skin easily. When terminals of impedance instrument are connected to the electrodes, an alternating current in the magnitude of 0.1 - 2.0 mA at the frequency of about 1-1000 KHz is passed between the distal pair of hand and foot electrodes. Between the inner pair of the wrist and ankle electrodes, the resistance of the body is measured.

In the conventional BIA method, four electrodes are applied on the skin of the wrist, the hand, the ankle, and the foot. Then a current is injected into the body and a voltage difference is measured. This is 4-electrode method in which a pair of electrodes are used for the current injection and the other pair

are used for the voltage detection.

In the conventional method, an examinee should lie on a bed and sticky electrodes are applied on the skin. A calculation process is often required to obtain body composition following the impedance measurement. Because of these cumbersome measurement processes, it is difficult to use it. In addition, the conventional method measures the whole body impedance only and thus individual variations in segmental distribution of lean mass produces measurement errors. In the conventional method, electrodes should be applied on the designated location precisely and the measurement errors are often induced in the electrode application process. It is of further inconvenience that hairs should be removed for the electrode application. The above conventional method requires a long period time for the measurement.

OBJECTS OF THE INVENTION

It is an object of the present invention to provide an apparatus for analyzing body composition by measuring the electrical impedance, in which body composition is measured in a simple and convenient manner without a specially trained examiner, like when measuring the weight on a scale.

It is another object of the present invention to provide an apparatus for measuring the body impedance quickly and conveniently, in which a person contacts the surface of the plate electrodes with his palms and soles instead of appling sticky electrodes on the skin.

It is a further object of the present invention that the contact

resistance is reduced effectively by using a large contact area between the body and the electrodes.

It is a further object of the present invention that the weight is automatically measured by stepping on the machine, the examinee or patient data can be easily typed in using a key pad.

It is a further object of the present invention that the body composition results are displayed on a display unit and are printed out immediately following the measurement.

It is a further object of the present invention that impedance is measured for the body segments as well as the whole body.

It is a further object of the present invention that body composition results are provided for the body segments as well as the whole body.

SUMMARY OF THE INVENTION

An apparatus for analyzing body composition according to the present invention comprises:

metal plate electrodes 1, 2, 3 and 4 contacting the palms and the soles;

an impedance measuring instrument 5 for measuring impedance of the body using the current voltage ratio, which includes a terminal T_1 consisting of a pair of current C_1 and voltage V_1 terminals and a terminal T_2 consisting of a pair of current C_2 and voltage V_2 terminals, thereby an alternating current in the magnitude of 0.1-2.0 mA between 1 KHz and 1 MHz passes between said terminals T_1 and T_2 and a voltage

difference is measured between said terminals T_1 and T_2;

electronic switches 6 connecting said plate electrodes to said impedance measuring terminals T_1 and T_2;

a load cell 10 for measuring the weight;

a key pad 11 for inputting the patient data such as height, age, and sex;

a microprocessor 18 for calculating the body composition results using measured data;

amplifier 15 and filter 16 and A/D converter 17 for interfacing said impedance meter 5 and weight measurement systems 10 to said microprocessor 18; and

a display unit 12 for displaying the results.

In a body composition analyzer according to the present invention, the results analyzed by a microprocessor 18 are displayed on a display unit 12 and can be printed out with a printer 14.

A method for analyzing body composition according to the present invention comprises:

connecting a pair of current C_1 and voltage V_1 electrodes to one plate electrode;

connecting the other pair of current C_2 and voltage V_2 electrodes to the other plate electrode;

controlling the on/off of the switch 6 with a microprocessor 18;

measuring segmental body impedances;

measuring the weight of a body with a load cell 10;

inputting patient data such as the height, age, sex on a key pad 11;

calculating body compositions such as total body water, fat free mass and percent body fat with a microprocessor 18; and displaying the analyzed results on a display unit 12; and/or printing the analyzed results out with a printer 14.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 schematically illustrates electrical connections between four plate electrode analyzer and impedance measuring terminals;

Fig. 2 schematically illustrates electrical connections between two plate electrode analyzer and impedance measuring terminals;

Fig. 3 is a schematic view of the invented analyzer using four plate electrodes;

Fig. 4 is a schematic view of the invented analyzer using two plate electrodes;

Fig. 5 illustrates components of the analyzer and their electrical connections;

Fig. 6 illustrates the conventional measurement of the body impedance in which electrodes are attached on the skin of the right hand and foot;

Fig. 7 is an electrical model of the body; and

Fig. 8 illustrates electrical connections for measuring segmental impedance of the body.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Reference will now be made to the drawings wherein like structures will be provided with like reference designations.

Fig. 1 schematically illustrates electrical connections between four plate electrode analyzer and impedance measuring terminals. Fig. 3 is a schematic view of the invented analyzer using four plate electrodes, and Fig. 5 illustrates components of the analyzer and their electrical connections. An apparatus for analyzing body composition according to the present invention comprises metal plate electrodes 1, 2, 3 and 4 contacting the palms and the soles; an impedance measuring instrument 5 for measuring impedance of the body using the current voltage ratio, which includes a terminal T_1 consisting of a pair of current C_1 and voltage V_1 terminals and a terminal T_2 consisting of a pair of current C_2 and voltage V_2 terminals, thereby an alternating current in the magnitude of 0.1-2.0 mA between 1 KHz and 1 MHz passes between said terminals T_1 and T_2 and a voltage difference is measured between said terminals T_1 and T_2; electronic switches 6 connecting said plate electrodes to said impedance measuring terminals T_1 and T_2; a load cell 10 for measuring the weight; a key pad 11 for inputting the patient data such as height, age, and sex; a microprocessor 18 for calculating the body composition results using measured data; amplifier 15 and filter 16 and A/D converter 17 for interfacing said impedance meter 5 and weight measurement systems 10 to said microprocessor 18; and a display unit 12 for displaying the results.

In the body composition analyzing apparatus of the present

invention, the results are displayed on the display unit 12, and when needed, a printer(14) can be added for printing the results.

In a conventional impedance method, four surface electrodes 19, 20, 21 and 22 are attached on the wrist, the back of hand, the ankle and the back of foot as shown in Fig. 6, electrically connecting the human body to an impedance measuring instrument. Then an electrical current is injected between the hand and the foot and voltage measured between the wrist and the ankle by 4-electrode method.

The 4-electrode method utilizes a pair of current electrodes and a pair of voltage electrodes. In a state of supine posture, electrodes are attached on the skin of the body. When an impedance measuring device is connected to these attached electrodes, the device passes a sine wave current in the magnitude of 0.1-2.0mA at the frequency of about 1-1000 KHz between electrode C1 and C2, measures a voltage difference between electrodes V1 and V2, and then calculate the body impedance using the voltage-current ratio.

Resistance(R) is a function of the length(L), the cross-sectional area(A), and the resistivity(ρ) of the conductor,

$$R = \rho L/A \qquad \text{(E1)}$$

Equation E2 is found by multiplying L to the numerator and denominator of the right side of equation E1,

$$R = \rho L^2/(AL) \qquad (E2)$$

The volume of the conductor is a function of the length L and the cross-sectional area A. Thus

$$R = \rho L^2/R \qquad (E3)$$

Total body water (TBW) and fat free mass (FFM) are conductive mass in the body. Assuming that the length of the conductive mass is replaced by the height(Ht) and the resistivity(ρ) is constant between individuals. TBW and FFM can be expressed by equation E4.

$$\text{TBW or FFM} = C_1 \cdot Ht^2/R + C_2 \qquad (E4)$$

In equation E4, constants C1 and C2 are determined by the regression between Ht^2/R and TBW or FFM. Once the prediction equation is completed, TBW and FFM can be found by inserting body resistance and height into equation E4. Total body fat(FAT) is found by the body weight minus FFM, and the percent body fat is defined by equation E5.

$$\text{percent body fat (\%BF)} = 100\,(Wt - FFM)/\,Wt \qquad (E5)$$

In the present invention, 2-electrode method is used, where impedance is measured between terminals T1 and T2. A pair of current C1 and voltage V1 terminals are connected to terminal

T1 and the other pair of current C2 and voltage V2 terminals are connected to terminal T2. On the other hand, terminal T1 is connected to one or two plate electrodes and terminal T2 is connected to one or two plate electrodes which are not connected to terminal T1. When the body is touched to the plate electrodes, the impedance of the body is measured between terminals T1 and T2.

The 2-electrode method can reduce the number of electrodes. However, this method has a contact resistance problem between the skin of the body and the electrodes. Therefore the body composition analyzer according to the present invention utilizes a large contact surface area which reduces the contact resistance. In addition, electrolytes-rich cream or solution applied on the palm and the sole can reduce the contact resistance further.

A method for analyzing body composition according to the present invention comprises connecting a pair of current C_1 and voltage V_1 electrodes to one plate electrode; connecting the other pair of current C_2 and voltage V_2 electrodes to other plate electrodes; controlling the on/off of the switch 6 with a microprocessor 18; measuring segmental body impedances; measuring the weight of a body with a load cell 10; inputting patient data such as the height, age, sex on a key pad 11; calculating body compositions such as total body water, fat free mass and percent body fat with a microprocessor 18; and displaying the analyzed results on a display unit 12; and/or printing the analyzed results out with a printer 14.

According to the present impedance method, four plate electrodes are used when a person steps on foot electrodes 3

and 4 with the bare feet and touches hand electrodes 1 and 2 with the palm, the impedance of segmental body is measured. The impedance of a body segment can be used to determine segmental composition as well as whole body composition.

In another method, two electrodes are used, where palms contact one electrode and soles contact the other electrode. The electrical circuit of the two electrode analyzer is shown in Fig. 2. Fig. 4 is a schematic view of a body composition analyzer using two plate electrodes.

As shown in Fig. 4, an apparatus according to the present invention includes a hand electrode 7 for contacting the palms, a foot electrode 8 for contacting the soles, an impedance measuring instrument 5, a weight scale 10, an automatic ruler 13, a microprocessor 9, and interfacing electronics 15, 16 and 17 and a printer 14.

As shown in Fig. 4, a key pad for inserting the patient data such as age and sex, and a display unit can be included.

Using a body composition analyzer according to the present invention, impedance of a body segment such as a right arm, a left arm, a right leg, and a whole body can be measured.

Fig. 7 illustrates electrical model of body segments. As shown in Fig. 7, R_1, R_2, R_3, R_4, and R_5 are the resistances of the right arm, the left arm, the trunk, the right leg and the left leg, respectively. The whole body resistance (Rw) is measured between the palms and soles as shown in Fig. 8 and is expressed as equation E6.

$$Rw = (R_1 \cdot R_2)/(R_1 + R_2) + R_3 + (R_4 \cdot R_5)/(R_4 + R_5) \quad \text{(E6)}$$

The resistance of the right arm (R_1) plus the resistance of the left arm (R_2) is measured by a connection shown in Fig. 8(D) and is expressed as equation E7.

$$Ra = R_1 + R_2 \qquad (E7)$$

Resistance(Rw_{-2}) of the both legs and the left arm can be measured as shown in Fig. 8(F) and resistance (Rw_{-1}) of the both legs and the right arm can be measured as show in Fig. 8(E). These are expressed as equations E8 and E9.

$$Rw_{-2} = R_1 + R_3 + (R_4 \cdot R_5)/(R_4 + R_5) \qquad (E8)$$

$$Rw_{-1} = R_2 + R_3 + (R_4 \cdot R_5)/(R_4 + R_5) \qquad (E9)$$

Subtracting E9 from E8, Equation E10 is found.

$$Rw_{-2} - Rw_{-1} = R_1 - R_2 \qquad (E10)$$

From Equation E7 and E10, arm resistance R1 and R2 can be calculated.

$$R_1 = (Ra + Rw_{-2} - Rw_{-1})/2 \qquad (E11)$$

$$R_2 = (Ra + Rw_{-2} - Rw_{-1})/2 \qquad (E12)$$

Resistance of the right leg (R4) plus the resistance of the left leg(R5) can be measured as shown in Fig. 8(C) and can be

expressed as equation E13.

$$R\ell = R_4 + R_5 \qquad \text{(E13)}$$

Resistance(Rw-5) of the both arms and the right leg is measured as shown in Fig. 8(H) and resistance(Rw-4) of the both arms and the left leg is measured as shown in Fig. 8(G). These are expressed as equations E13 and E14.

$$Rw_{-5} = (R_1 \cdot R_2)/(R_1+R_2)+R_3+R_4 \qquad \text{(E14)}$$

$$Rw_{-4} = (R_1 \cdot R_2)/(R_1+R_2)+R_3+R_5 \qquad \text{(E15)}$$

Subtracting E15 from E14, equation E16 is found.

$$Rw_{-5} - Rw_{-4} = R_4 - R_5 \qquad \text{(E16)}$$

From equation E13 and E16, leg resistances R4 and R5 can be calculated.

$$R_4 = (R\ell + Rw_{-5} - Rw_{-4})/2 \qquad \text{(E17)}$$

$$R_5 = (R\ell + Rw_{-5} - Rw_{-4})/2 \qquad \text{(E18)}$$

Resistance(Rt) of the trunk is found by subtracting parallel resistance of arms and legs from the resistance of the whole body.

$$Rt = Rw - (R_1 \cdot R_2)/(R_1 + R_2) - (R_4 \cdot R_5)/(R_4 + R_5) \quad (E19)$$

Body composition such as total body water(TBW) and fat free mass(FFM) can be calculated by using Ht^2/Rw, where Ht is the height and Rw is the whole body resistance. Segmental resistance ratios such as Ra/Rt can be used as an additional predictor.

$$\text{TBW or FFM} = C_1 \cdot Ht^2/Rw + C_2 \cdot (Ra/Rt)Ht^2/Rw + C_3 \quad (E20)$$

In the above equation, constants C1, C2 and C3 are determined by the regression technique between impedance independent variables and TBW or FFM determined by a standard method. In the above equation, Ra can be replaced by Rl or Ra+Rl. Segmental composition is a function of segmental impedance. For example, FFM of the right arm is expressed as equation E21.

$$\text{FFM left arm} = C_1 \cdot Ht^2/Rw + C_2 \quad (E21)$$

The amount of body fat can be calculated by subtracting FFM from the weight.

$$Fat = Wt - FFM \quad (E22)$$

Percent body fat (%BF) is expressed as E23.

$$\%BF = 100 \times (Wt - FFM)/Wt \quad (E23)$$

An apparatus for measuring the impedance the body utilizes an alternating current in the magnitude of 0.1-2.0 mA at the frequency between 1 and 1000 KHz is frequently employed for a body composition analyzer.

In order to measure intracellular water (ICW) and extracellular water(ECW) separately, multifrequency technique measure the body impedance at a low frequency near 1 KHz and high frequency near 1 MHz. The impedance ratio measured at a high and low frequency, Rhigh/Rlow, can be used to calculate water distribution. For example, ECW to TBW ratio can be expressed by the following equation.

$$ECW/TBW = C_1 \cdot (Rhigh/Rlow) + C_2 \qquad (E24)$$

The technique for calculation water distribution can be applied to the body composition analyzer according to the present invention as well as a conventional technique.

In the conventional body composition analyzer, current and voltage electrodes are separately connected to the surface electrode. In the analyzer according to the present invention, a current and a voltage electrode are connected to a metal plate electrode according to two electrode method, and then the body contacts this surface electrode.

Using an body composition analyzer according to the present invention, an examinee steps on the foot electrodes 3 and 4 with bare feet and touches the hand electrodes 1 and 2 with the palms. The measurement can be done much like measurement

of the weight on the electronic scale. When using this body composition analyzer, a person with a light cloth inputs his height, age, sex, and then touches his palms on right hand electrode 1, left hand electrode 2 and steps on right foot electrode 3 and left foot electrode 4. Terminal T_1, consisting C_1 and voltage V_1 terminals, is connected to one or two electrodes and terminal T_2, consisting of current C_2 and voltage V_2 terminal, is connected to one or two electrodes which are not connected to terminal T_1. Impedance measuring instrument 5 measures the impedance of the body between terminals T_1 and T_2.

Electronic switches 6 change electrical connections between four electrodes 1, 2, 3 and 4 and terminals, T_1 and T_2, and measure segmental impedance of the body.

As show in Fig. 2 and Fig. 4, using a two electrode body composition analyzer, two palms touch hand electrode 7 and two soles touch foot electrode 8. Terminal T_1 is connected to the hand electrode 7, terminal T_2 is connected to the foot electrode 8, and then whole body impedance between the palms and the soles is measured.

A microprocessor 18 controls on/off of electronic switches 6 and measures segmental resistance as shown in Fig. 8(A)-(H).

Fig. 8(A) shows the measurement of the whole body between the hands and the feet, Fig. 8(B) shows the measurement between the right hand and the right foot, Fig. 8(C) shows the measurement between the left foot and the right foot, Fig. 8(D) shows the measurement between the left hand and the right

hand, Fig. 8(E) shows the measurement between the right hand the left foot, Fig. 8(F) shows the measurement between the left hand and the both feet, Fig. 8(G) shows the measurement between the right foot and the both hands, and Fig. 8(H) shows the measurement between the both hands and the both feet. The body weight is measured by a load cell located under the foot plate electrodes. A signal of the load cell is sent to the microprocessor 18 though a amplifier 15 and a filter 16 and A/D converter 17. The height is input on a key pad 11. In addition to the height, the age and sex are also input on the key pad 11. The microprocessor 18 calculates total body water (TBW), fat free mass (FFM) and percent body fat (%BF) using the measured values and the typed values. The results are displayed on a display unit 12 and/or are printed out with a printer 14.

The present invention makes it possible for a person to measure his body composition by himself much like a electronic weight measurement. The plate electrode method according to the present invention provides a highly reproducible electrical contacts between the body and the electrode without any special cautions. Further more a large contact area between the body and the electrodes reduces contact resistance effectively and measure impedance of the body reliably.

It should be apparent to those skilled in the art that variations and modifications can be added to the present invention which is limited only by the appended claims.

What is claimed is:

1. An apparatus for analyzing body composition comprising:

metal plate electrodes 1, 2, 3 and 4 contacting the palms and the soles;

an impedance measuring instrument 5 for measuring impedance of the body using the current voltage ratio, which includes a terminal T_1 consisting of a pair of current C_1 and voltage V_1 terminals and a terminal T_2 consisting of a pair of current C_2 and voltage V_2 terminals, thereby an alternating current in the magnitude of 0.1-2.0 mA between 1 KHz and 1 MHz passes between said terminals T_1 and T_2 and a voltage difference is measured between said terminals T_1 and T_2;

electronic switches 6 connecting said plate electrodes to said impedance measuring terminals T_1 and T_2;

a load cell 10 for measuring the weight;

a key pad 11 for inputting the patient data such as height, age, and sex;

a microprocessor 18 for calculating the body composition results using measured data;

amplifier 15 and filter 16 and A/D converter 17 for interfacing said impedance measuring instrument 5 and a load cell 10 to said microprocessor 18; and

a display unit 12 for displaying the results.

2. An apparatus for analyzing body composition according to claim 1 further including a printer 14 which prints said results

out.

3. An apparatus for analyzing body composition according to claim 1 further including an automatic ruler 13 which measures the height of an examinee.

4. An apparatus for analyzing body composition comprising:

a hand electrode 7 for contacting the palms;

a foot electrode 8 for contacting the soles;

an impedance measuring instrument 5 for measuring segmental impedances between said palms and soles;

a weight scale 10 for measuring the weight of an examinee;

an automatic ruler 13 for measuring the height of an examinee;

a microprocessor 9 for calculating the body composition results using measured data;

interfacing electronics 15, 16 and 17 for interfacing said impedance measuring instrument 5 and said weight scale 10 to said microprocessor 9; and

a printer 14 for printing out said results.

5. An apparatus for analyzing body composition according to claim 4 further including a key pad 11 for inputting the patient data such as height, age, and sex.

6. An apparatus for analyzing body composition according to claim 4 further including a display 12 for displaying said results.

7. A method for determining bioelectrical impedance using a two electrode method, which comprises:

connecting a pair of current C1 and voltage V1 terminals to terminal T1;

connecting the other pair of current C2 and voltage V2 terminals to terminal T2;

connecting terminal T1 to one or two plate electrodes which are not connected to terminal T1; and

connecting terminal T2 to one or two plate electrodes which are not connected to terminal T1.

8. A method for determining bioelectrical impedance using a two electrode method, which comprises:

connecting a hand electrode 7 to a terminal T_1 consisting of a pair of current C_1 and voltage V_1 terminals; and

connecting a foot electrode 8 to a terminal T_2 consisting of a pair of current C_2 and voltage V_2 terminals.

9. A method for analyzing body composition, which comprises:

connecting a pair of current C_1 and voltage V_1 electrodes to one plate electrode;

connecting the other pair of current C_2 and voltage V_2 electrodes to the other plate electrode;

controlling the on/off of the switch 6 with a microprocessor 18;

measuring segmental body impedances;

measuring the weight of a body with a load cell 10;

inputting patient data such as the height, age, sex on a key

pad 11;

calculating body compositions such as total body water, fat free mass and percent body fat with a microprocessor 18; and

displaying the analyzed results on a display unit 12.

10. A method according to claim 9 wherein said step of measuring segmental body impedances comprises:

connecting a pair of current C1 and voltage V1 terminals to terminal T1:

connecting the other pair of current C2 and voltage V2 terminals to terminal T2;

connecting terminal T1 to one or two plate electrodes which are not connected to terminal T1; and

connecting terminal T2 to one or two plate electrodes which are not connected to terminal T1.

11. A method according to claim 9 or 10 further including a step of printing out said results with a printer 14.

12. A method for analyzing body composition, which comprises:

connecting a hand electrode 7 to a terminal T_1 consisting of a pair of current C_1 and voltage V_1 terminals;

connecting a foot electrode 8 to a terminal T_2 consisting of a pair of current C_2 and voltage V_2 terminals;

measuring segmental body impedances;

measuring the weight of a body with a load cell 10;

measuring the height of a body with an automatic ruler 13;

calculating body compositions such as total body water, fat free mass and percent body fat with a microprocessor 9; and printing the analyzed results out with a printer 14.

13. A method according to claim 12 wherein said step of measuring segmental body impedances comprises:

connecting a hand electrode 7 to a terminal T_1 consisting of a pair of current C_1 and voltage V_1 terminals; and

connecting a foot electrode 8 to a terminal T_2 consisting of a pair of current C_2 and voltage V_2 terminals.

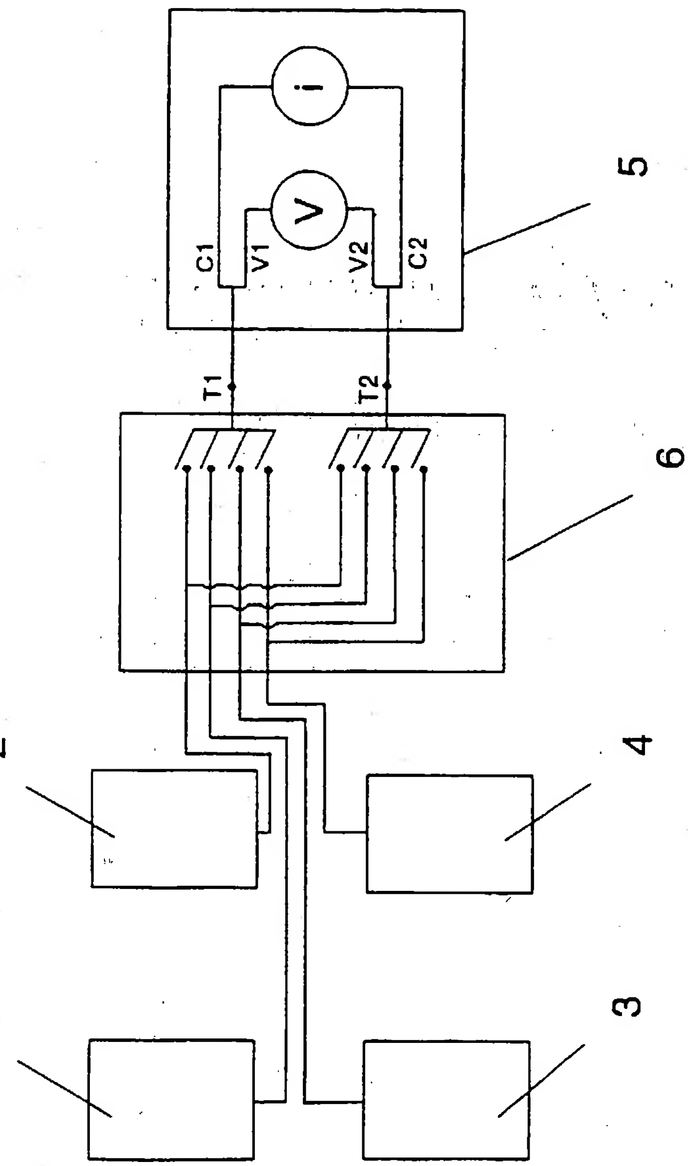


FIG. 1

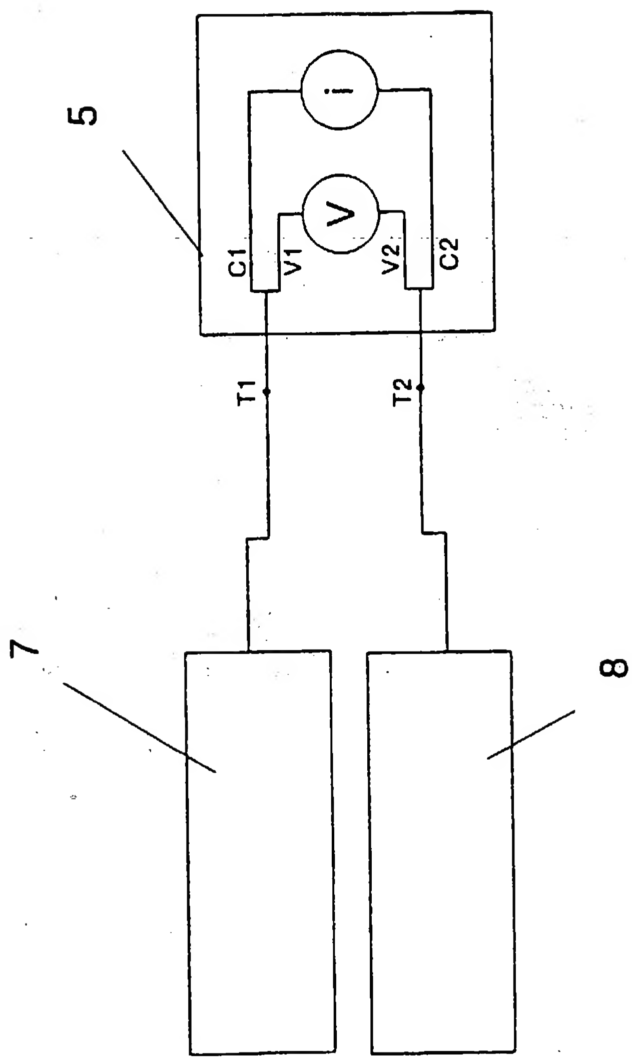
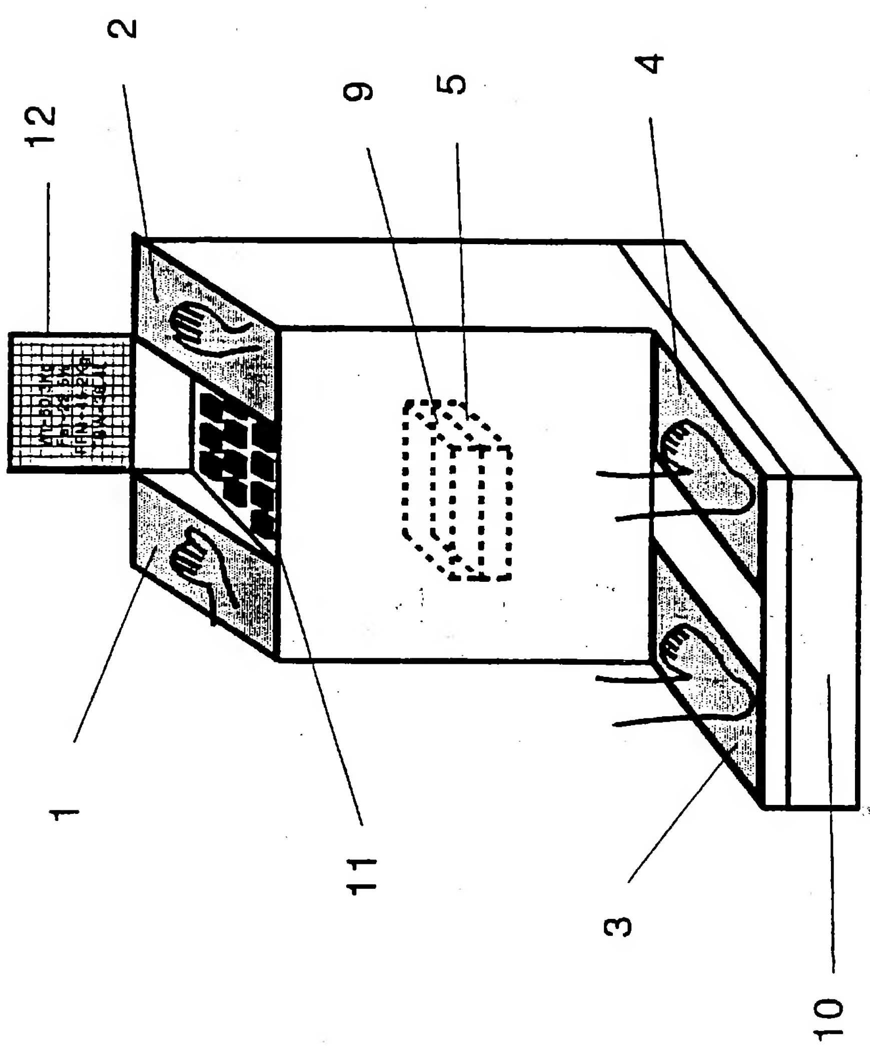


FIG. 2

FIG. 3



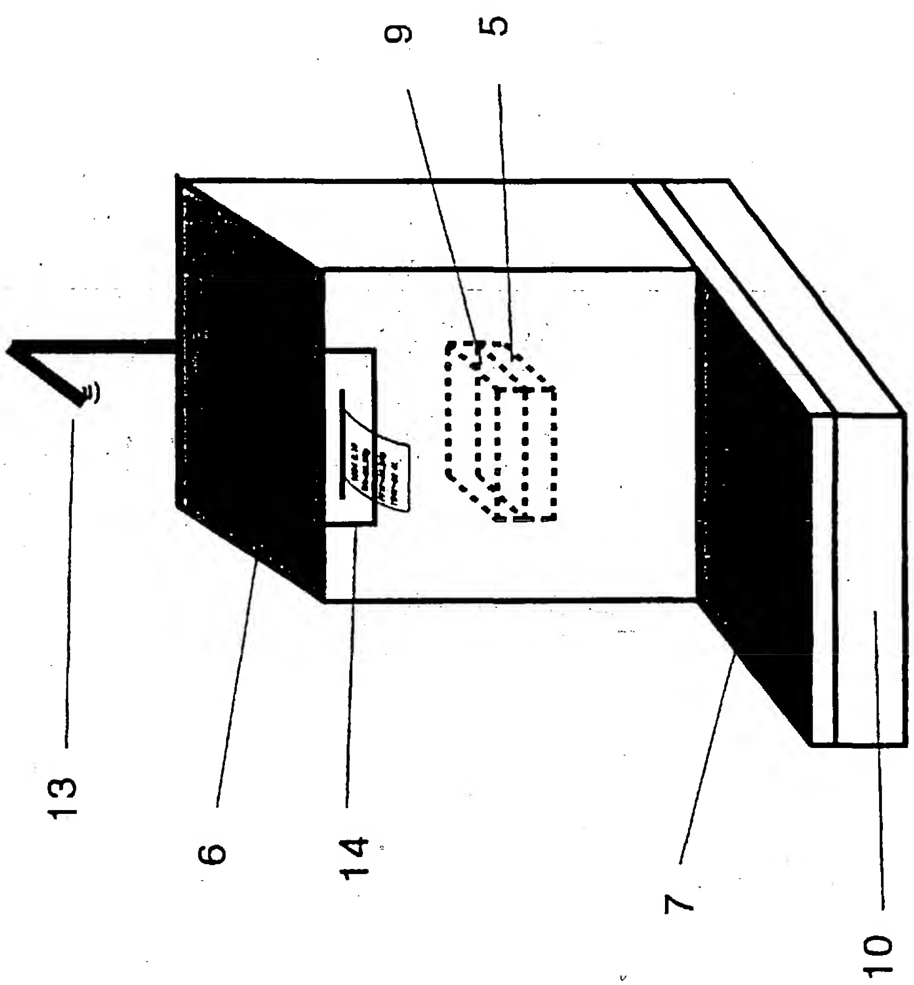
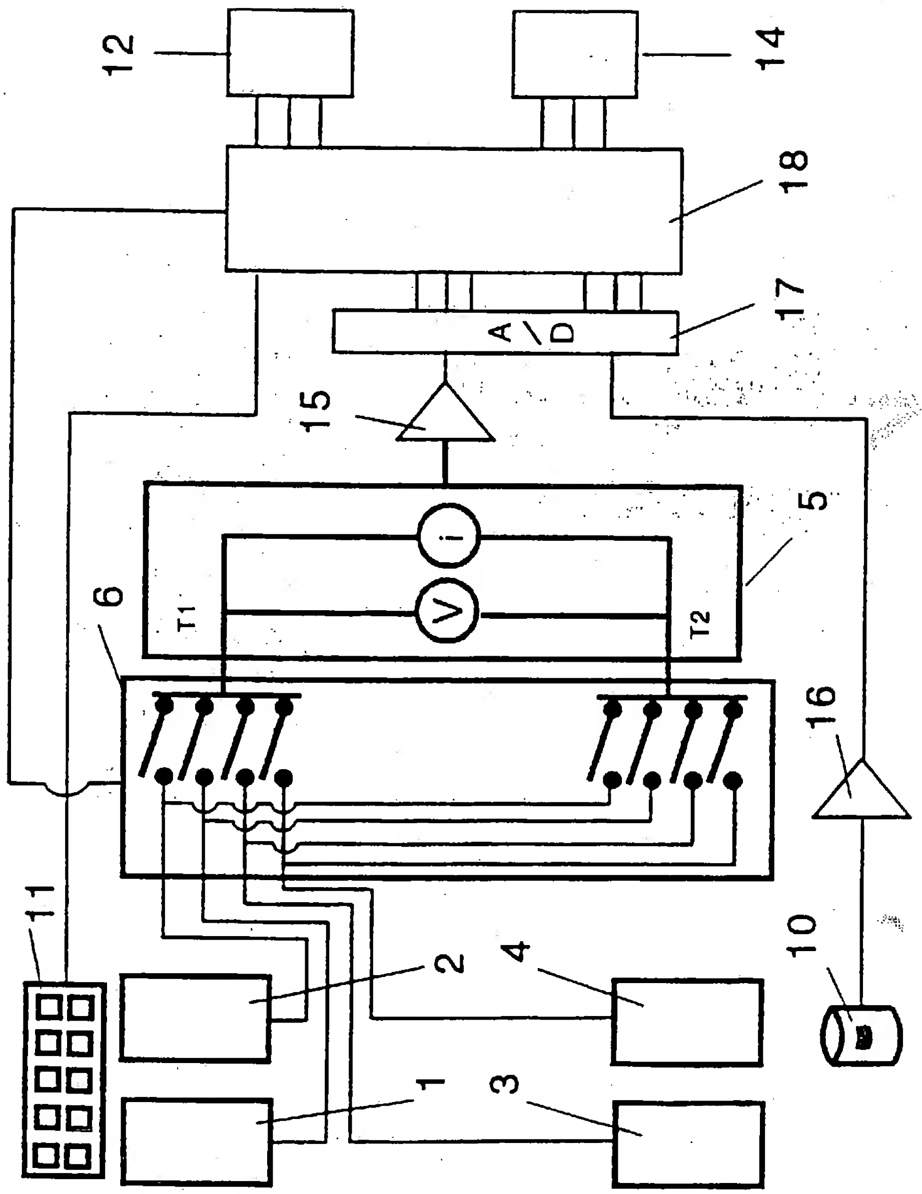


FIG. 4

FIG. 5



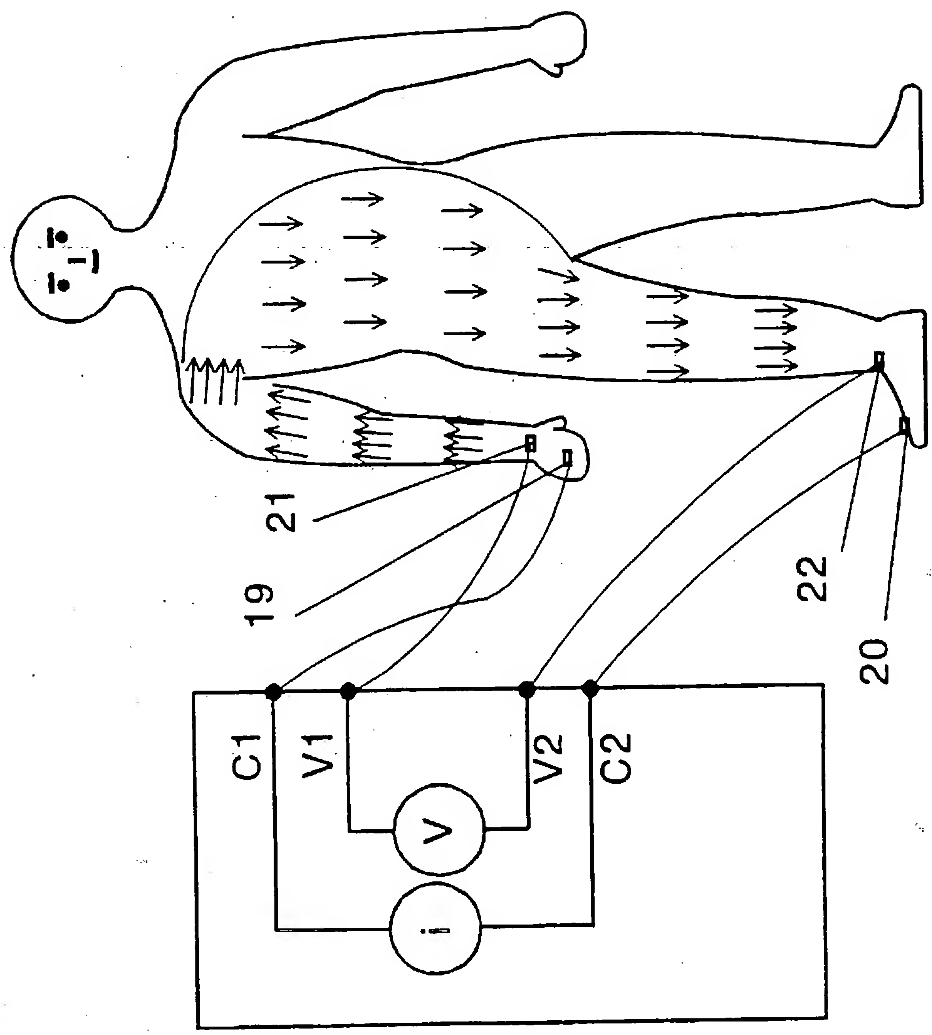


FIG. 6

FIG. 7

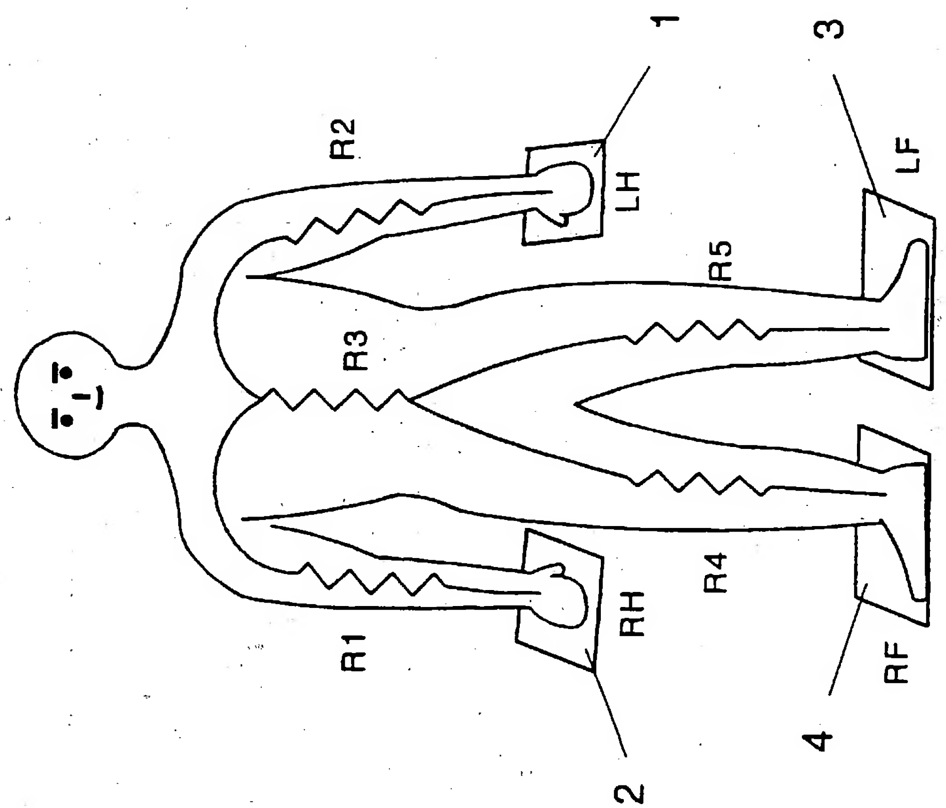


FIG. 8A

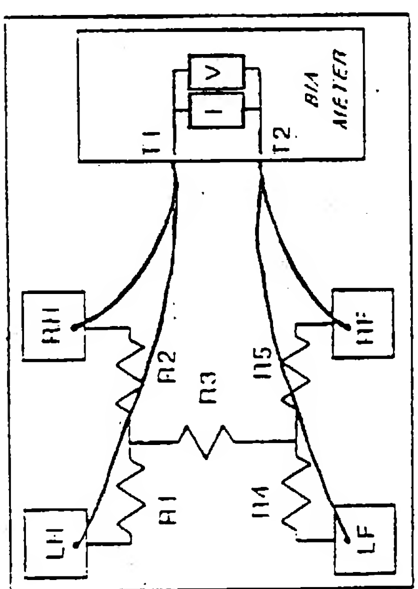


FIG. 8B

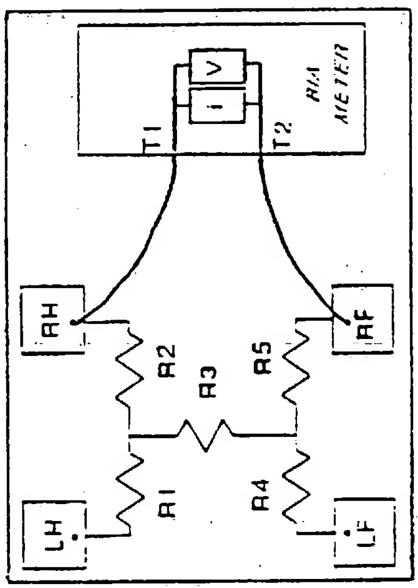


FIG. 8C

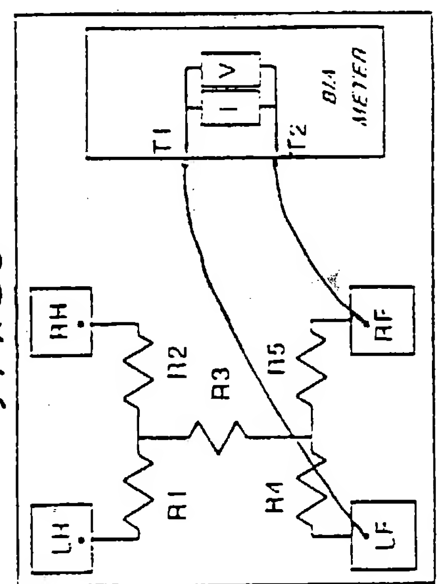
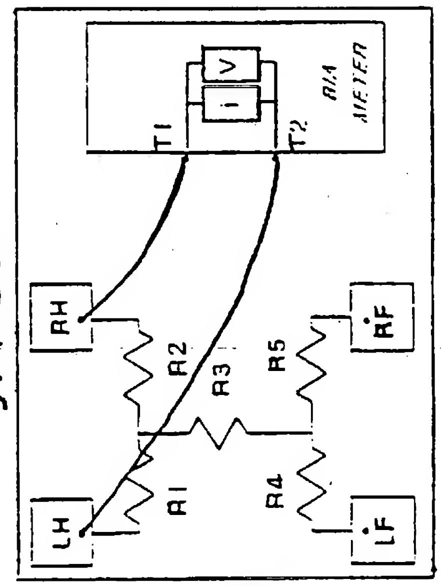


FIG. 8D



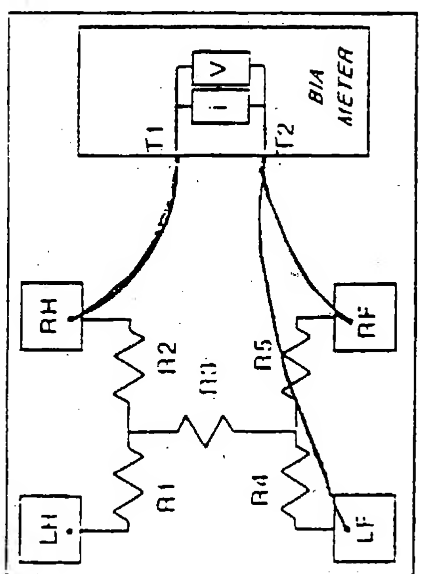


FIG. 8E

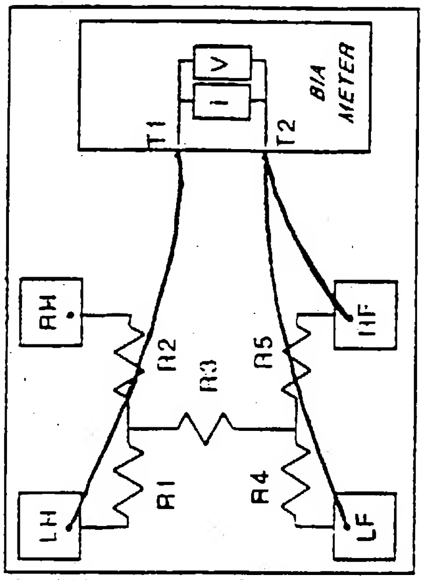


FIG. 8F

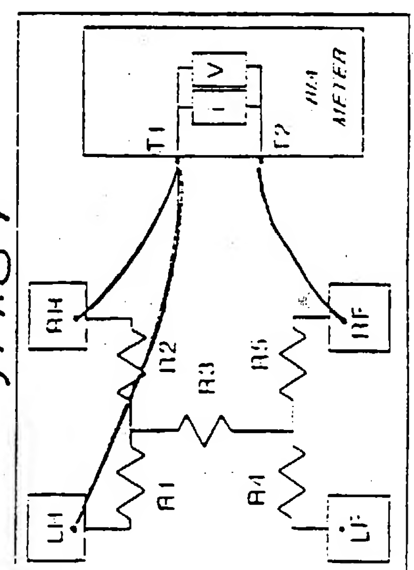


FIG. 8G

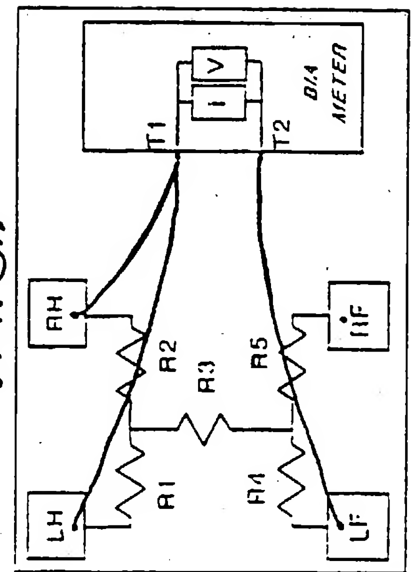


FIG. 8H

SUBSTITUTE SHEET

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR 95/00119

A. CLASSIFICATION OF SUBJECT MATTER

IPC^6: A 61 B 5/05

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC^6: A 61 B 5/05

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	US 4 947 862 A (KELLY) 14 August 1990 (14.08.90), abstract; fig. 1,2; column 1, lines 1-40; column 2, lines 19-41; column 4, lines 58-68.	1 4
A	US 5 335 667 A (CHA) 09 August 1994 (09.08.94), abstract; fig. 1; column 3, lines 5-24; column 4, line 55 - column 5, line 6; claims.	4,5,6,7,8
A	FR 2 698 779 A1 (EUGEDIA) 10 June 1994 (10.06.94).	1
A	EP 0 343 928 A2 (BIOANALOGICS) 29 November 1989 (29.11.89).	1

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date f the actual completion of the international search	Date of mailing of the international search report
20 December 1995 (20.12.95)	28 December 1995 (28.12.95)

Name and mailing address of the ISA/ AT	Authorized officer
AUSTRIAN PATENT OFFICE Kohlmarkt 8-10 A-1014 Vienna	Zawodsky e.h.
Facsimile No. 1/53424/535	Telephone N . 1/53424/346

Im Recherchenbericht angeführtes Patentdokument Patent document cited in search report Document de brevet cité dans le rapport de recherche	Datum der Veröffentlichung Publication date Date de publication	Mitglied(er) der Patentfamilie Patent family member(s) Membre(s) de la famille de brevets	Datum der Veröffentlichung Publication date Date de publication
US A 4947862	14-08-90	keine - none - rien	
US A 5335667	09-08-94	keine - none - rien	
FR A1 2698779	10-06-94	FR B1 2698779	13-01-95
EP A2 343928	29-11-89	AU A1 34649/89	30-11-89
		CA A1 1315848	06-04-93
		EP A3 343928	27-12-90
		JP A2 2060626	01-03-90
		US A 4895163	23-01-90
		US A 5449000	12-09-95

FIG. 1

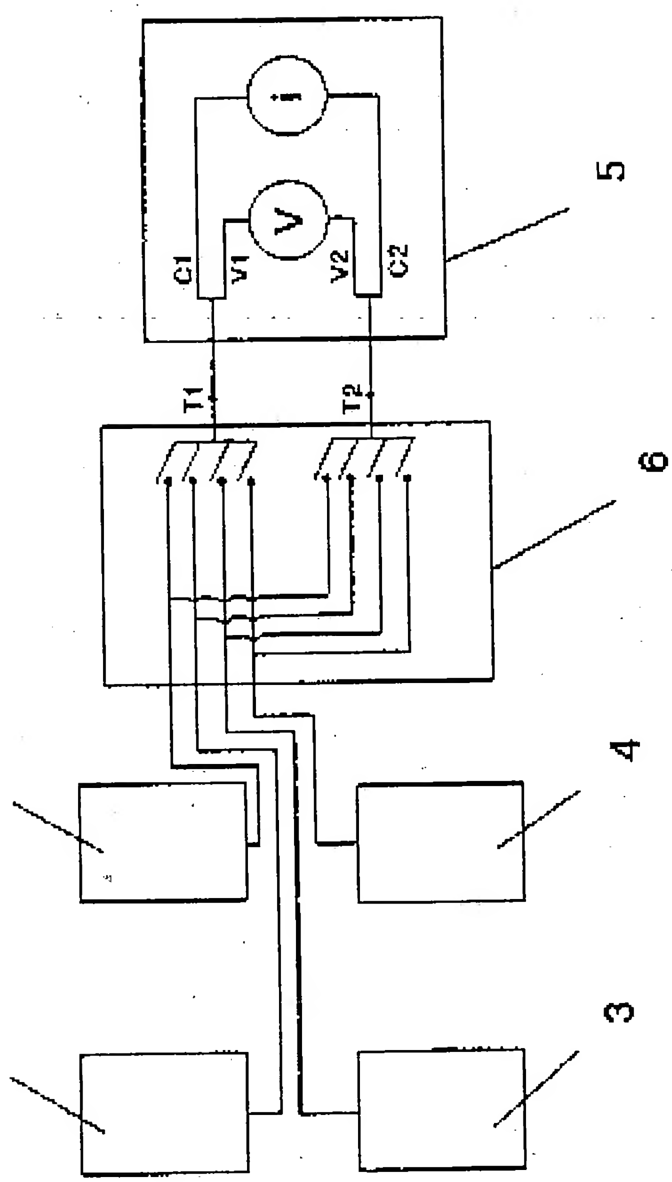


FIG. 2

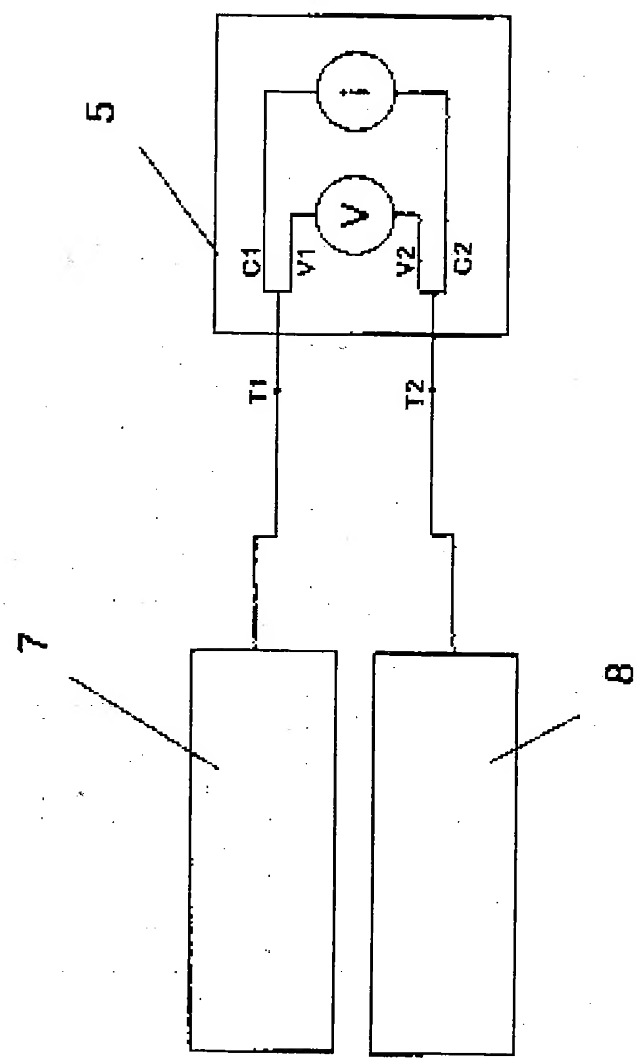


FIG. 3

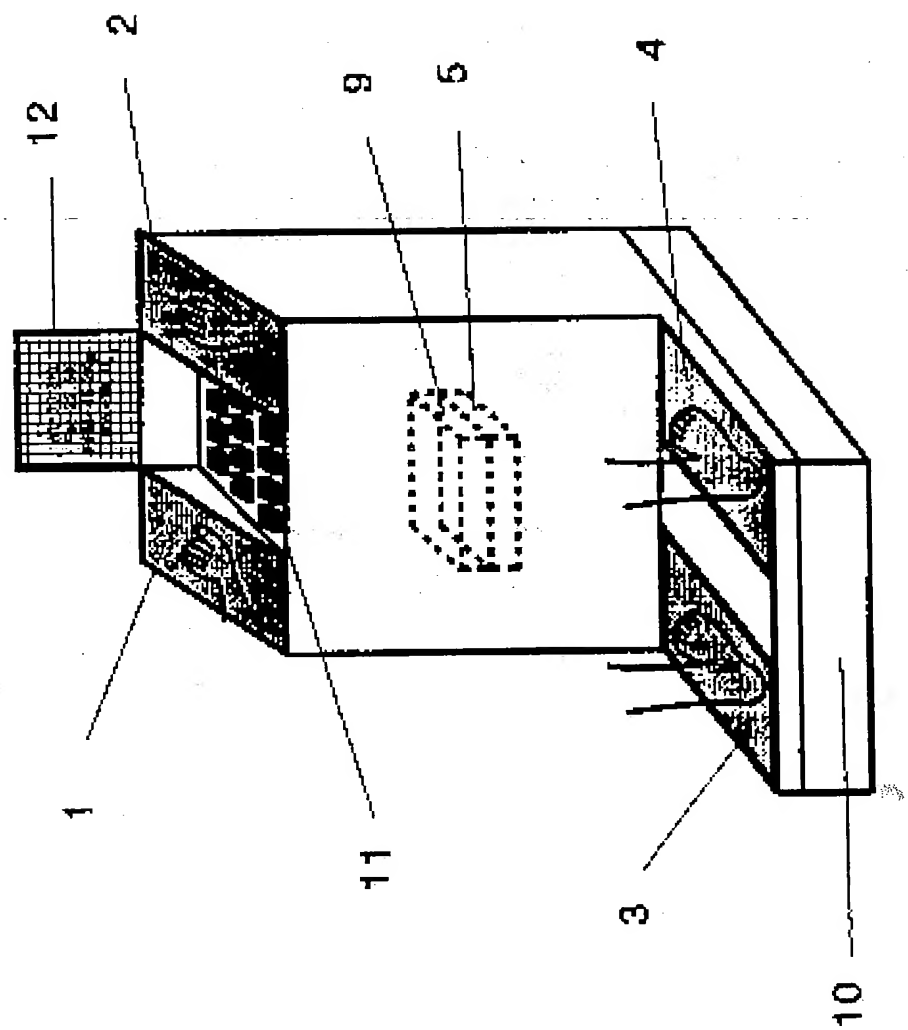


FIG. 4

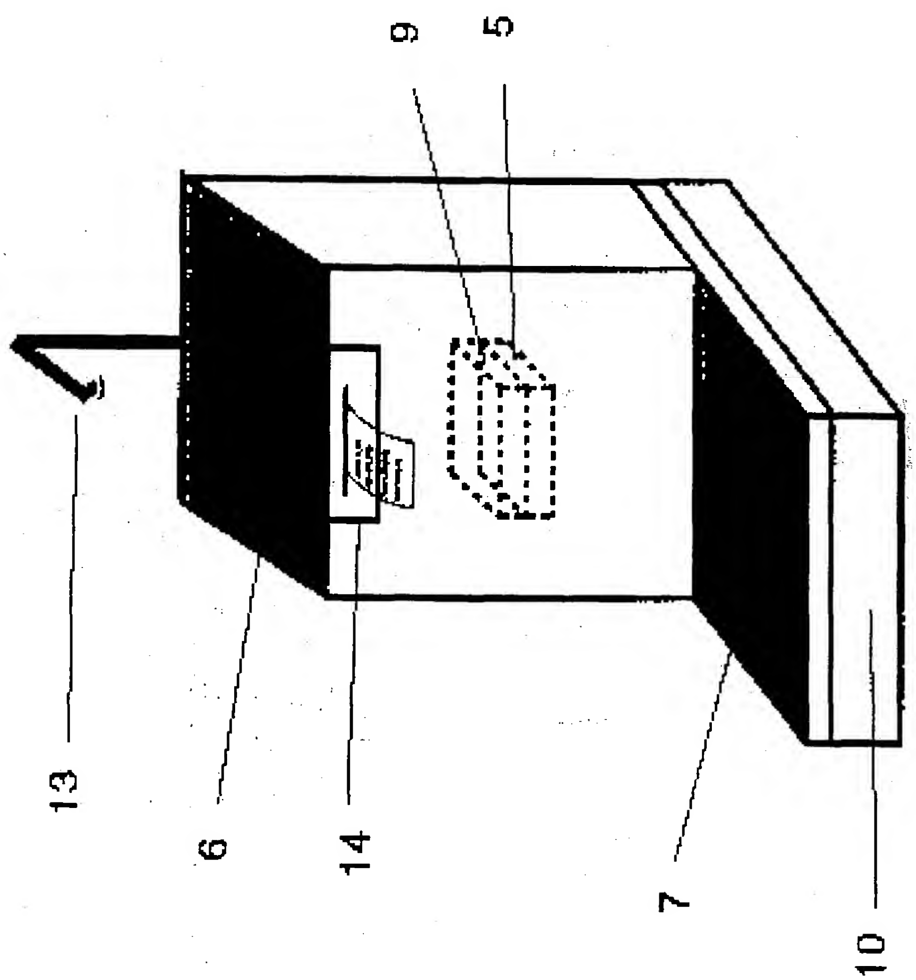


FIG. 5

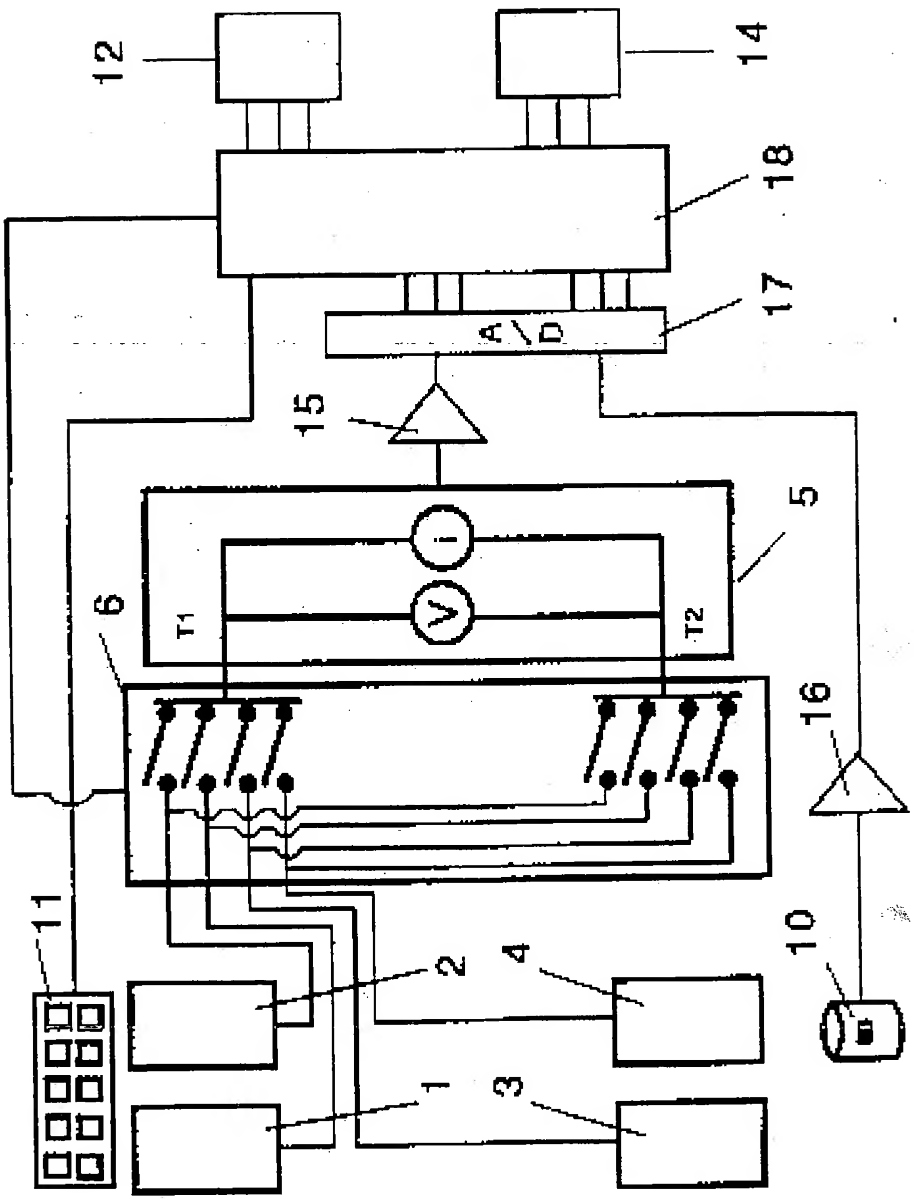


FIG. 6

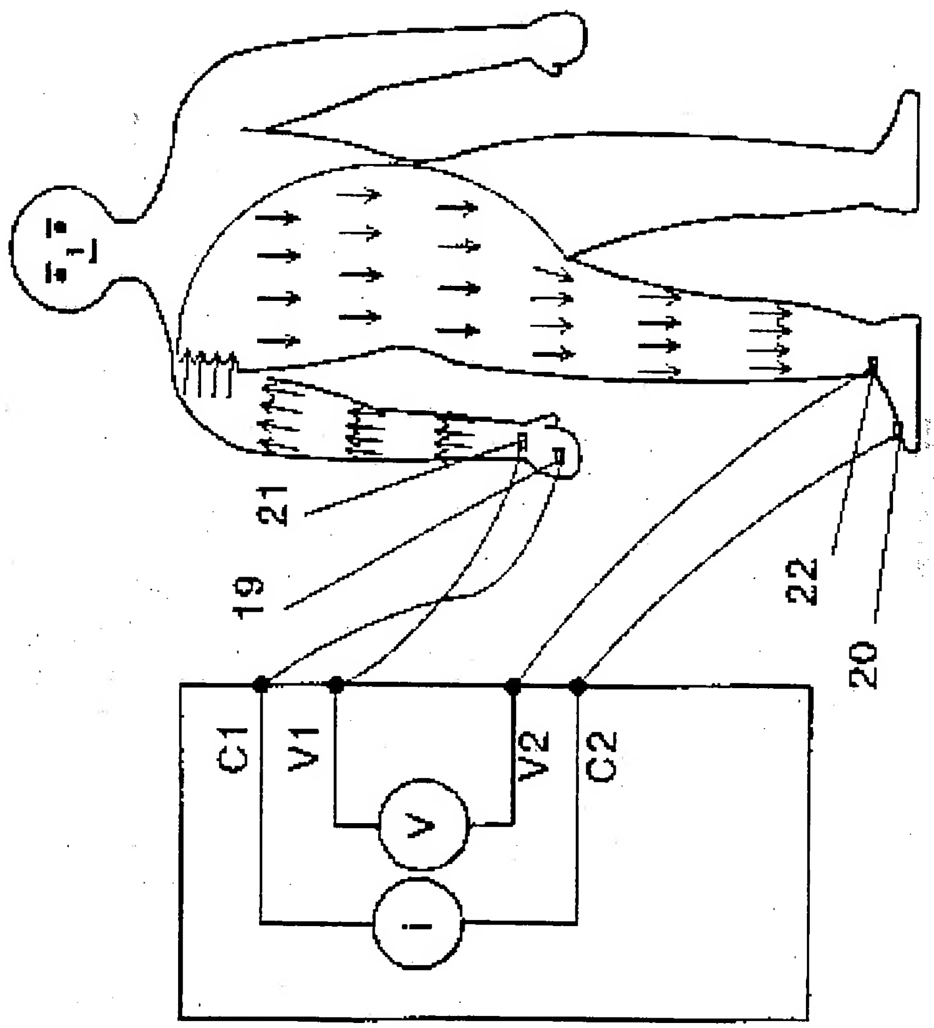


FIG. 7

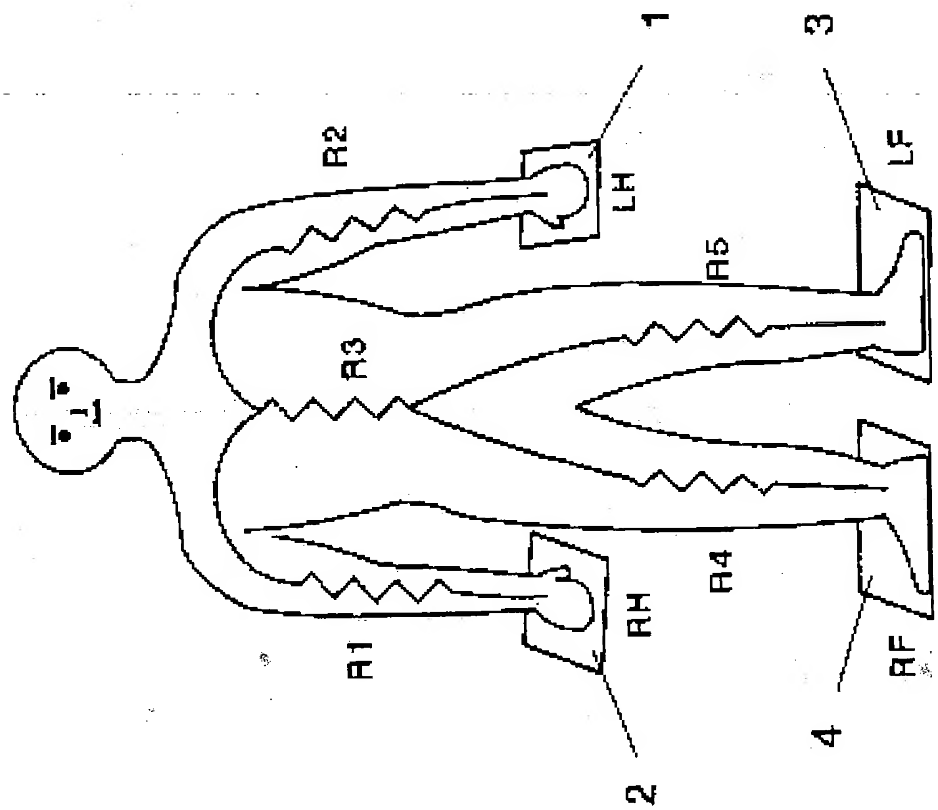
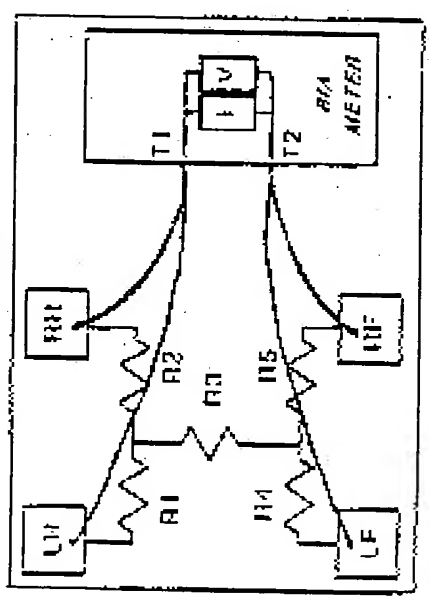


FIG. 8A



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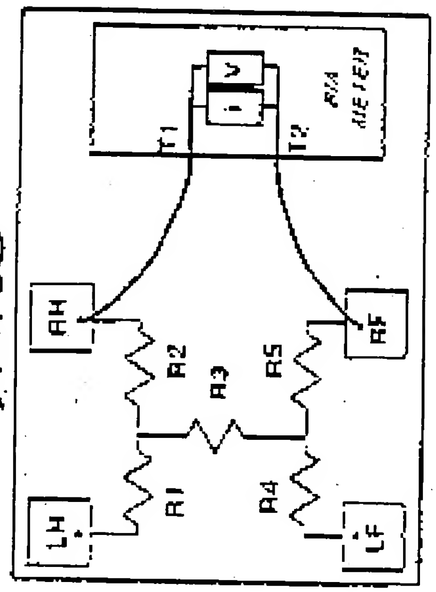


FIG. 8C

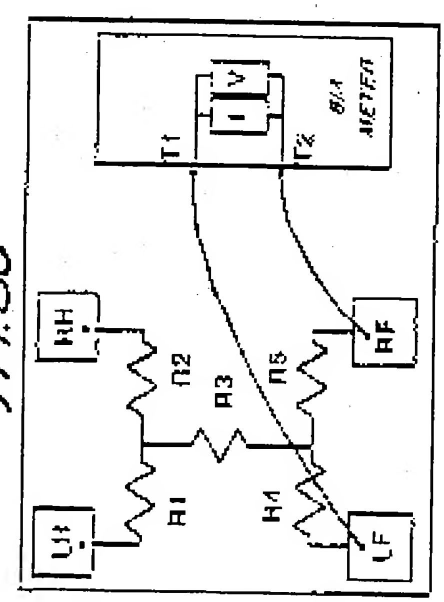
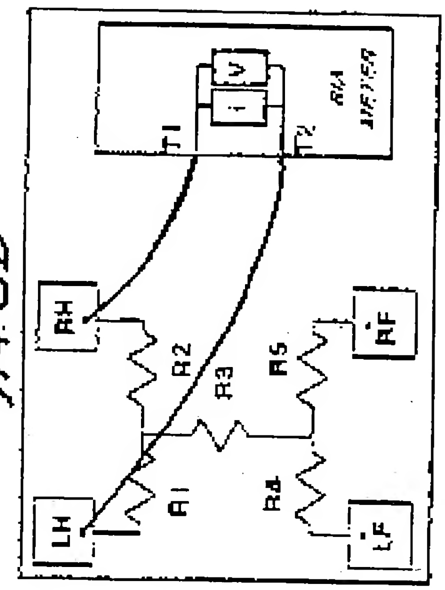


FIG. 8D



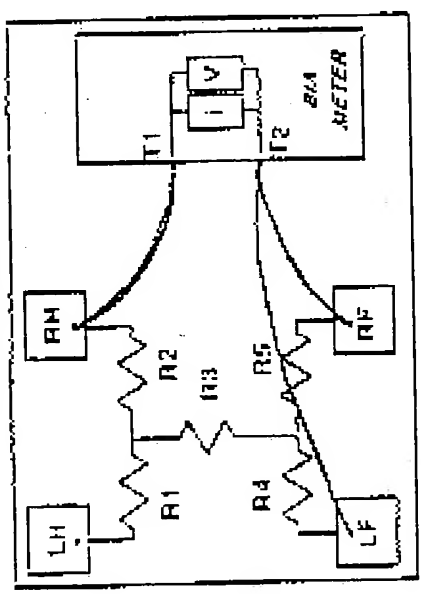


FIG. 8E

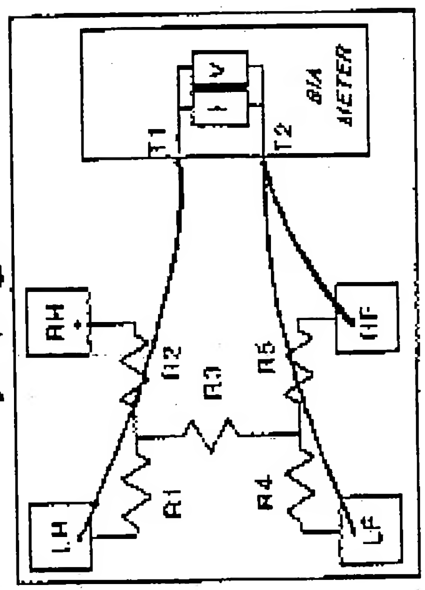


FIG. 8F

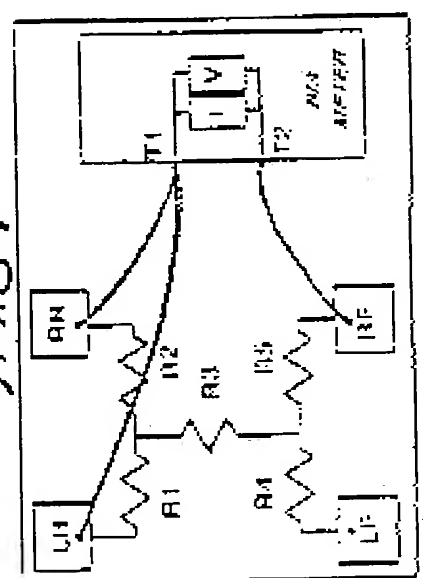


FIG. 8G

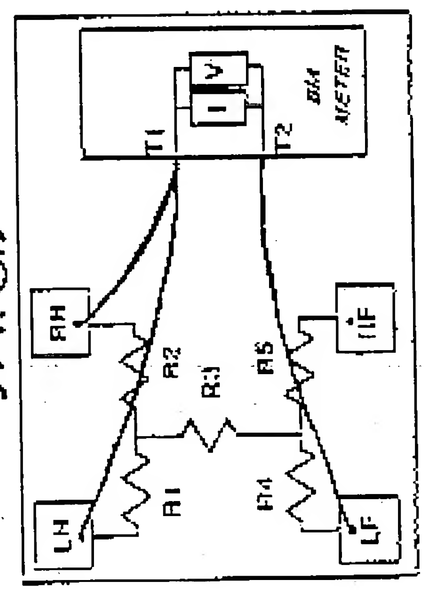


FIG. 8H